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FROM SWITZERLAND**

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COST AND SCALE EFFICIENCY IN THE NURSING HOME SECTOR: EVIDENCE FROM SWITZERLAND*

by

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ABSTRACT

This paper examines costs in the nursing home industry, an issue of concern to Swiss policy makers because of the explosion of elderly care costs and the aging of the population. Moreover, the fact that Swiss nursing homes are managed by different forms of institutional organizations (private for-profit nursing homes, government nursing homes and nonprofit nursing homes) raises the issue of their relative cost efficiency.

The paper considers an estimation of a deterministic frontier cost model and two versions of a stochastic frontier cost model. A translog cost function was estimated using panel data for a sample of 38 nursing homes for elderly people operating over the period 1993-1995 in the Canton Ticino, which is located in the Italian-speaking part of Switzerland. Using a set of dummy variables, quality differences and differences in the forms of institutional organization are considered.

The results of this analysis show that the institutional form influences the relative cost-efficiency of the nursing home.

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1. INTRODUCTION

The dramatic rise in health care costs in recent years and the Government's budget deficit have placed increasing pressure on Swiss hospitals and nursing homes to contain costs and to improve their cost efficiency. Moreover, this pressure is bound to be greater in the nursing home sector, because the number of the elderly is growing and it is well known that the costs of health and social care rise very rapidly with age. About one half of all women and a third of all men who turn 65 will need intensive care for periods that average two years before they die. As a result, nursing home efficiency issues are of great interest to governments and have direct public policy relevance in a way similar to that of hospitals.

In Switzerland, long-term care for the elderly is supplied by private for-profit nursing homes, local government nursing homes and nonprofit nursing homes, respectively. However, only local government nursing homes and nonprofit nursing homes receive subsidies from the government. Moreover, nonprofit nursing homes are foundations created by private people or by municipalities (town councils?).

This mixed economy within that characterises the long-term care market raises the interesting issue of the effects on costs of the different ownership and institutional organization forms. Hence, the following two questions become central for the policy makers: are for-profit nursing homes more efficient than nonprofit nursing homes? Are local government nursing homes more efficient than nonprofit nursing homes?

A number of recent studies have compared the cost efficiency of nonprofit and for-profit hospitals and nursing homes; however, little empirical analysis has been done in the comparison of the cost efficiency of government and nonprofit nursing homes.¹

It is often presumed that nonprofit nursing homes are more efficient than local government nursing homes. A theoretical rationale for this hypothesis has been derived from public choice theory, which focuses on the incentives offered to (?) politicians and bureaucrats running a public enterprises. The basic idea of the models presented by Niskanen (1968, 1971) is that for bureaucrats responsible for delivering a fixed amount of output within a budget, the tendency is to over-budget and to attempt to produce more bureaucratic output than is socially optimal (acceptable / sustainable (?). To reach this goal they have incentives (are to respond to the demands of the political process with its different distribution of power. For politicians the incentive is to shift costs and benefits so that the net benefits to their constituency are positive. This leads to political optimization which may

clast with cost efficiency. On the other hand, managers of nonprofit nursing homes may likewise have no optimal incentive to be efficient, since efficiency cannot lawfully (legally?) be rewarded. However, the incentive for these managers to be efficient may be the relatively greater personal satisfaction in providing a particular social service than their public counterpart.² Moreover, in the case of Swiss nursing homes, the decisional process of a foundation is more flexible and not influenced by politicians.

The purpose of the present study is to make a contribution to this debate through the development and econometric estimation of a translog total cost frontier function of local government and nonprofit nursing homes operating in the Canton Ticino.³ These nursing homes are regulated in terms of quality standards and rates by the Cantonal government, which subsidises their operating costs.

The results of this study are, therefore, relevant to several issues concerning the reform of the welfare state. First, they contain information about economies of scale, and, therefore, of scale inefficiency, in the nursing home sector. Second, they provide criteria for assessing the impact of an institutional organization on cost efficiency. Third, they contribute to an evaluation of the viability of public and nonprofit nursing homes in the supply of long-term care for elderly people.

The article is organized as follows. Section 2 presents the cost frontier model for the nursing homes industry. Section 3 illustrates the data relating to 38 Swiss nursing homes. Section 4 shows the parameter estimates of the total cost function and other empirical results. Section 5 examines policy implications while section 6 presents some conclusions.

2 COST FRONTIER MODELS FOR THE SWISS NURSING HOMES

2.1 Cost frontier models

A frontier cost function defines minimum costs given output level, input prices and the existing production technology. It is unlikely that all firms will operate at the frontier. Failure to attain the cost frontier implies the existence of technical and allocative inefficiency.

¹ See for example Vitalino & al. (1994), Bradford and Mobley (1997) and McKeay (1990).

² See Weisbrod (1997) for an interesting presentation of the efficiency incentives of nonprofit organizations.

³ The cantonal government collects only data on subsidized nursing homes. Therefore, the available data set does not contain information about the private for-profit nursing homes.

Different approaches can be used to estimate a frontier cost function with panel data. A good overview is given by Battese (1992) and Simar (1992).

In this paper we consider the estimation of a deterministic and two versions of a stochastic frontier cost function using panel data. The deterministic approach constrains the error term of the cost function to be non negative. To illustrate this basic econometric approach consider the cost function:

$$\ln C_{it} = \ln C(y_{it}, w_{it}) + u_{it} \quad u_{it} \geq 0 \quad i = 1, 2, \dots, N \text{ and } t = 1, 2, \dots, T \quad (1)$$

where C_{it} is observed cost in year t , y_{it} is a vector of outputs, w_{it} is an input price vector and u_{it} is a positive one-sided disturbance capturing the effect of inefficiency (a mixture of allocative and technical inefficiency); N represents the number of firms involved in a cross-sectional survey of the industry and T the years of observation. Firms can therefore operate on or above the cost frontier but not below it. One interesting method proposed for estimating equation (1) is Greene's (1980) version of Richmond's (1974) "corrected ordinary least squares" (COLS method). A functional form for the cost function is assumed, and parameter estimates are obtained using ordinary least squares (OLS) estimation techniques. The intercept is corrected by shifting the value of the intercept until no residual is positive and at least one is zero. This is done by adjusting the constant term using the negative OLS residual with the highest absolute value. This method is also called Displaced Ordinary Least Square (DOLS) approach. Greene (1980) has shown that the resulting constant term is consistent but biased and of unreliable efficiency.

The main shortcoming of this method is that it confuses inefficiency with statistical noise: the entire residual is classed as inefficiency. Nevertheless many studies have used this approach.⁴

This problem can be overcome using the stochastic cost frontier approach suggested by Aigner et al. (1977):

$$\ln C_{it} = \ln C(y_{it}, w_{it}) + u_i + v_{it} \quad u_i \geq 0 \quad i = 1, 2, \dots, N \text{ and } t = 1, 2, \dots, T \quad (2)$$

⁴ See for example Wagstaff (1989) and Filippini and Maggi (1993).

In this specification the error term is composed of two parts: the first, u_i , is a one-sided non negative disturbance reflecting the effect of inefficiency (a mixture of allocative and technical inefficiency); the second, v_{it} , is a two-sided disturbance capturing the effect of noise. The statistical noise is assumed to follow a normal distribution, and the inefficiency term u_i is generally assumed to follow either an exponential or truncated normal distribution.

The main advantage of the stochastic cost frontier approach compared to the deterministic approach is therefore the separation of the inefficiency from the statistical noise. However, this stochastic method is subject to the potential criticism of having an arbitrary assumption about the distribution of the inefficiency term.

To overcome this problem we consider also the estimation of a stochastic frontier cost function using another approach suggested by Schmidt and Sickles (1984) for panel data. In this approach the overall residual w_{it} is also composed of two terms ($w_{it} = u_i + v_{it}$): a symmetric component of the disturbance v_{it} that allows for noise and a one-sided component u_i that represents cost inefficiency.⁵ The attractiveness of this approach is that using panel data and a fixed effects model specification, no assumptions need be made about the distributions of u_i .⁶ In this approach, inefficiency u_i is treated as a fixed effect, and therefore a set of firm specific binary variables is introduced in the model. The fixed effects approach captures any unobservable firm specific effect, such as inefficiency, that are not explained by any of the control variables.

There are, however, two limits to this approach, namely that one has to be prepared to assume that inefficiency remains constant over time and that time invariant variables cannot be included in the model.

2.2 Specification of the Frontier Cost Function for the Nursing Homes

The costs of operating a nursing home are the costs of the building and the equipment and the costs of take care of the residents. These costs may depend upon:

- the total number of resident-days of nursing home care;
- the type and quality of care provided per resident day;

⁵ For a presentation of this method see Schmidt and Sickles (1984) and Simar (1992).

⁶ In this approach the term stochastic is referred to the fact that the model is stochastic (presence of a symmetric component of the disturbance v_{it}) but not the inefficiency term u_i . In the approach suggested by Aigner et al. (1977) both the model and the inefficiency term are stochastic.

- the level of the required assistance by the residents with normal daily activities such as eating , personal care or performing physiological functions;
- the level of the required medical assistance by the residents;
- the capacity of the nursing home;
- the institutional form;
- the price of labor; and
- the price of capital.

A nursing home can, therefore, be represented as a firm transforming two inputs into patient-days of nursing home care. Moreover, in the cost model specification we take into account a number of output characteristic variables, which should capture the heterogeneity dimension of the output of a nursing home.

Assuming that output and input prices are exogenous, and that (for a given technology) firms adjust input levels so as to minimize costs, the firm's total cost of operating a nursing home can be represented by the cost function

$$TC = h (Y, Q1, Q2, P_K, P_L, DIF, DAPP, T) \quad (3)$$

where TC represents total cost and Y is the output represented by the total number of patient-days of nursing home care. P_K and P_L are the prices of capital and labor, respectively. Q1 is an index that measures the average required assistance of a home's patients with normal daily activities such as eating, personal care or performing physiological functions. This index is calculated yearly by the Regional Department of Public Health. Q2 is the ratio of the number of nurses employed by a nursing home to the number of nurses that should be theoretically be employed according to the guidelines of the Regional Department of Public Health.⁷ These two variables, Q1 and Q2, are therefore introduced in the model as output characteristics. In order to test for the effects of the form of the institutional organization on the cost efficiency we introduce in the model a dummy variable DIF which is equal 1 for nursing homes managed by a nonprofit organization and 0 for nursing homes managed by the local government. Moreover, we introduce in the model a second dummy variable, DAPP, in order to distinguish nursing homes which offer the possibility for a relatively small part of the people to live with a small support in an apartment located beside

⁷ The nursing homes are not obliged to exactly follow the guidelines of the regional Department of Public Health.

the main building. T is a time variable which captures the shift in technology representing change in technical efficiency.

The properties of the cost function (1) are that it is concave and linearly homogeneous in input prices and non-decreasing in input prices and output.⁸

Estimation of the cost function (1) requires the specification of a functional form. The translog cost function offers an appropriate functional form for answering questions about economies of scale.⁹ Most important for our purposes, it imposes no a priori restrictions on the nature of technology, allowing the values for economies of scale to vary with output.

$$\begin{aligned} \ln\left(\frac{TC}{P_K}\right) = & \alpha_0 + \alpha_y \ln y + \alpha_{Q1} \ln Q1 + \alpha_{Q2} \ln Q2 + \alpha_L \ln\left(\frac{P_L}{P_K}\right) + \frac{1}{2} \alpha_{yy} (\ln y)^2 + \frac{1}{2} \alpha_{Q1Q1} (\ln Q1)^2 \\ & + \frac{1}{2} \alpha_{Q2Q2} (\ln Q2)^2 + \frac{1}{2} \alpha_{LL} \left(\ln \frac{P_L}{P_K}\right)^2 + \alpha_{yL} \ln y \ln \frac{P_L}{P_K} + \alpha_{yQ1} \ln y \ln Q1 + \alpha_{yQ2} \ln y \ln Q2 \\ & + \alpha_{Q2Q1} \ln Q2 \ln Q1 + \alpha_{LQ1} \ln \frac{P_L}{P_K} \ln Q1 + \alpha_{LQ2} \ln \frac{P_L}{P_K} \ln Q2 + \alpha_{DF} DIF + \alpha_{DAPP} DAPP + \alpha_T T \end{aligned} \quad (4)$$

Since linear homogeneity in factor prices is imposed, the price of capital will act as a numeraire.

3. THE DATA

This study is based on a combined time series and cross-sectional data set for 38 nursing homes for elderly people operating over the period 1993-1995 in Canton Ticino which is located in the Italian-speaking part of Switzerland. Switzerland is a confederation composed of 26 cantons and approximately 3000 communes. This federal state is characterized by a high degree of decentralization in the provision of public services. For instance, each canton is very independent in the organization and regulation of the provision of long-term care for elderly people. Moreover, some cantons decentralize this task to the municipalities, while others tend to organize the provision of this service at the cantonal level.

The nursing home industry in the Canton Ticino consists of a mixture of approximately 20 private for-profit nursing homes, 23 government nursing homes and 19

⁸See Cornes (1992), p.106.

⁹ A translog function requires the approximation of the underlying cost function to be made at a local point, which in our case is taken at the median point of all variables. Thus, all independent variables are normalized at their median point.

non-profit nursing homes. Moreover, the local government nursing homes are generally operated by local municipalities or by consortiums of municipalities.

The local government and the nonprofit nursing homes are regulated in terms of rates and quality and receive subsidies from the cantonal government, whereas the private for-profit nursing homes are regulated only in terms of quality and do not receive subsidies from the Canton.

For regulatory purposes, each year the nursing homes are required to send to the cantonal Department of Public Health information on operating costs and on the characteristics of the residents. Thus, the data set used in this study has been created using the information contained in these annual reports by the not-for-profit nursing homes.

Total cost is taken to be the total expenditures of the nursing homes. Output is measured in total number of patient-days of nursing home care. Average yearly wage rates are estimated as the weighted mean of the average wage rates of the different professional categories working in a nursing homes: doctors, nurses, administrative and technical staffs.

Following Friedlaender and Wang Chiang (1983) and Filippini e Maggi (1993), the capital price is calculated from the residual capital costs divided by the capital stock. Residual cost is total cost minus labor cost. According to Wagstaffs (1989), the capital stock is approximated by the number of beds owned and operated by a nursing homes. Unfortunately no data are available which would allow us to calculate the capital stock using the capital inventory method. The quality indicators, Q1 and Q2 are calculated yearly by the regional Department of Public Health. All input prices, total cost and variable cost were deflated to 1996 constant Swiss francs using the Consumer Price Index. Some details of these variables are presented in Table 1.

Table 1 Descriptive statistics

<i>Variables</i>	Unit of measurement	<i>1. Quartile</i>	<i>Median</i>	<i>3. Quartile</i>
<i>Total cost</i>	SwF.	2498000	3412500	4736300
<i>Labour price</i>	SwF. For worker unit	68862	71654	75110
<i>Capital price</i>	SwF. For a unit of capital	8828	10119	11900
<i>Output</i>	total number of patient-days	15160	20187	26733
<i>Q1</i>		2.27	2.44	2.59

<i>Q2</i>	%	80	89	95
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4. ESTIMATION RESULTS

In this section we report the econometric results obtained from estimating the total frontier cost function model specified in equation (4) and using the data described in the previous section. For comparison purposes, we present the results obtained using three different approaches: DOLS, the fixed effect frontier and the stochastic frontier.¹⁰ The shortcoming of the fixed-effects version of model (5) is that it does not allow the estimation of the coefficient of the time-invariant dummy variables DIF and DAPP. Therefore, the estimation results of Model 2 do not allow the influence of the institutional form on the cost efficiency to be tested directly. However, by employing regression analysis to explain differences in estimated inefficiency indicators from the fixed effect frontier model, therefore using a two-stages approach, it is possible to analyze the effect of the institutional form on the cost efficiency.

The estimated coefficients and their associated standard errors of these three versions of the cost frontier model (4) are presented in Table 2. The estimated functions are well behaved. All the first order parameters and part of the second order parameters estimates are statistically significant. The coefficients of Model 1 and Model 2 are somewhat similar, whereas the coefficients of Model 3, the fixed effects model, show some differences. The reasons for these differences can be imputed to the relatively small within variation of the relevant explanatory variables in comparison to the between variation.¹¹ For instance in our sample we observe that the between variation of Y and Q1 is much larger than the within variation.

Since total cost and the regressors are in logarithms and have been normalized, the first order coefficients are interpretable as cost elasticities evaluated at the sample median. All these coefficients have the expected signs and are highly significant. The output elasticity is positive and implies that an increase in the supply will increase total cost. A 1% increase in the number of patient-days of nursing home care will increase the total cost in Model 1 by approximately 0.85% , in Model 2 by 0.75%, and in Model 3 by 85%, respectively.

¹⁰ The DOLS and the Fixed Effects models have been estimated using the computer program, LIMDEP 7.0, while the stochastic frontier has been estimated using the computer program FRONTIER 4.1, written by Tim Coelli (1996).

¹¹ See Baltagi and Griffin (1984) for a presentation of this problem in estimating energy demand model using panel data..

The cost elasticities with respect to the output characteristics variables, Q1 and Q2, are positive and imply that an increase in the average required assistance of a home's patients or an increase in the ratio of the number of nurses employed by a nursing home and the number of nurses that should theoretically be employed will increase total cost.

Table 2 : Total cost parameter estimates (standard errors in parentheses)

<i>Parameters</i>	<i>Model 1</i> <i>DOLS</i>	<i>Model 2</i> <i>Fixed effects</i>	<i>Model 3</i> <i>Stochastic frontier</i>
<i>Constant</i>	15.028*** (0.024)	"Individual constants"	14.982*** (0.030)
α_Y	0.850*** (0.023)	0.749*** (0.101)	0.854*** (0.0257)
α_{Q1}	0.707*** (0.097)	0.525*** (0.242)	0.780*** (0.099)
α_{Q2}	0.619*** (0.074)	0.486*** (0.151)	0.628*** (0.069)
α_{PL}	0.852*** (0.038)	0.769*** (0.060)	0.846*** (0.035)
α_{YY}	0.239** (0.101)	0.047 (0.179)	0.229** (0.100)
α_{Q1Q1}	-0.792 (1.078)	0.805 (1.628)	-0.175 (1.010)
α_{Q2Q2}	0.241 (0.183)	0.418** (0.210)	0.304* (0.164)
α_{PLPL}	0.193 (0.159)	0.579** (0.262)	0.355 (0.155)
α_{YQ1}	-0.138 (0.318)	0.155 (0.345)	0.203 (0.284)
α_{YQ2}	0.056 (0.181)	0.037 (0.222)	0.004 (0.165)
α_{YPL}	-0.044 (0.068)	-0.050 (0.109)	-0.062 (0.059)
α_{Q2PL}	0.431** (0.166)	0.037 (0.314)	0.455** (0.147)
α_{Q1PL}	0.537* (0.305)	0.347 (0.414)	0.528** (0.266)
α_{Q1Q2}	0.362 (0.364)	-0.765 (0.617)	0.204 (0.329)
α_{DFOND}	-0.054** (0.018)	—	-0.060** (0.021)
α_{APP}	-0.003 (0.025)	—	0.020 (0.028)
α_T	-0.001 (0.009)	0.012 (0.009)	-0.003 (0.010)
R ²	0.986	0.993	0.992

*, **, *** significantly different from zero at the 90, 95 and 99 % confidence level.

The labor and capital cost shares are positive, implying that the cost function is monotonically increasing in input prices. In all versions of the cost model the labor accounts for approximately 80% of the nursing homes operating costs while capital accounts for approximately 20%.

The direction and the magnitude of the effect of the institutional organization on cost can be seen from the coefficient of the DIF dummy variable. The negative coefficient on DIF implies that nonprofit nursing homes have, *ceteris paribus*, significantly lower costs than public nonprofit homes. Moreover, in Model 2, approximately 90% of the fixed-effects coefficients (firm-specific dummy variables) were significantly different from 0.¹²

Parameter estimates of the three versions of the translog cost function satisfy the regularity condition of concavity in input prices at the median point of approximation, which requires that the own-price elasticities of inputs be negative and that the Hessian Matrix, $[\partial^2 C / \partial w_i \partial w_j]$, be negative semi-definite. Because homogeneity in input prices and symmetry of the second order terms were imposed, the estimated functions satisfy all regularity conditions of a theoretically valid total cost model.

5 EFFICIENCY OF THE SWISS NURSING HOMES

In this section, a closer look is taken at the estimation results as far as efficiency is concerned. Basically, two different concepts of efficiency are used: scale and cost efficiency.

5.1 Scale efficiency

Scale efficiency indicates the degree to which a company is producing at optimal scale. Frisch (1965) defines the optimal scale as the level of operation where the scale elasticity is equal to one. Economies of scale (ES) are defined as the proportional increase in total cost resulting from a proportional increase in output (Y), holding all input prices fixed. This is equivalent to the inverse of the elasticity of total cost with respect to the output (Caves, Christensen, and Tretheway 1984) :

¹² Tables 2 omits the estimated coefficients of the firm specific dummy variables; a copy of these coefficients is available from author.

$$ES = \frac{1}{\frac{\partial \ln TC}{\partial \ln Y}} \quad (5)$$

We will talk of economies of scale if ES is greater than 1, and accordingly, identify diseconomies of scale if ES is below 1. In the case of ES = 1 no economies or diseconomies of scale exist. Economies of scale exist if the average costs of a nursing home decrease as output increases.

The estimation results from both Model 1, Model 2 and Model 3 indicate that economies of scale are present in the production of the Swiss nursing homes. Table 3 presents in more detail the results for small, medium-sized and large nursing homes, respectively. We note that all values of the indicator for economies of scale are greater than 1, which means that the majority of the nursing homes operate at an inappropriately low scale.

Table 3 Economies of scale ¹³

Nursing home size	small Patient-days = 15160 Bed capacity = 41	medium Patient-days = 20187 Bed capacity = 57	large Patient-days = 26733 Bed capacity = 80
ES _{Model 1}	1.19	1.18	1.15
ES _{Model 2}	1.36	1.34	1.31
ES _{Model 3}	1.19	1.18	1.14

The average cost (AC) curves implied by our estimated translog Model 3 appear in Figure 1, evaluated with all variables other than output set to their sample median. This curve is “L” shaped and indicate the presence of economies of scale at least for small and medium-

¹³ Equation (5) has been evaluated at the input prices and output characteristic variables, Q1 and Q2, of the median nursing home.

sized nursing homes. The economies of scale are exhausted up to a capacity of about 120 beds.

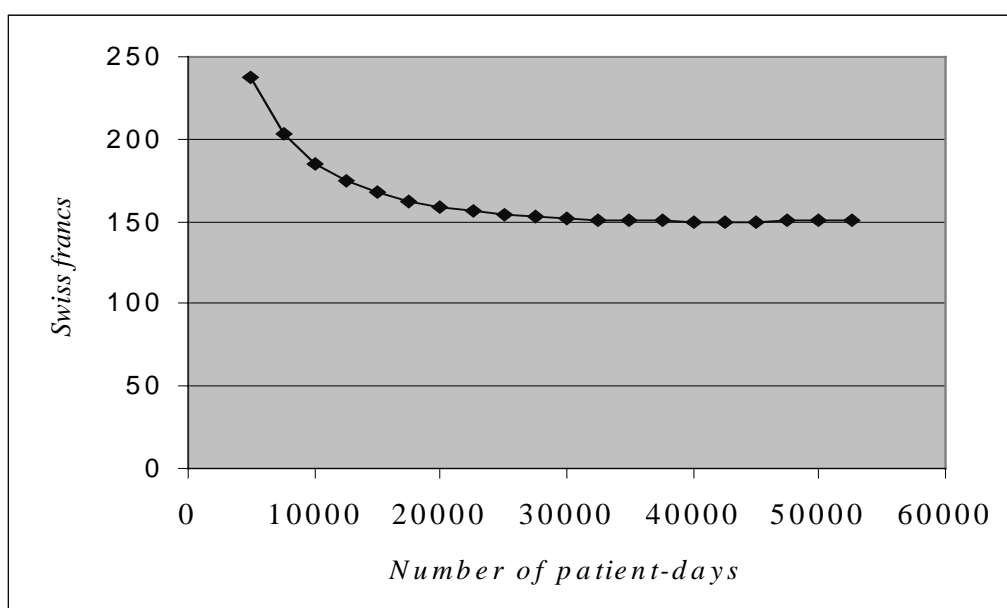


Figure 1 - Estimated AC curve empirical results of Model 3

5.2 Cost efficiency

The estimation results reported in Table 2 can be used to recover estimates of the level of cost inefficiency of each nursing home along the line suggested by Simar (1992) and Battese and Coelli (1996). This amounts to counting the most efficient nursing home in the sample as 100% efficient and measuring the degree of cost inefficiency of the other nursing homes relative to the most efficient one.

The predicted cost efficiency indicator ranges between 60 to 98%. The mean cost efficiency of nursing homes is estimated to be 74.4% in Model 1, 72.3% in Model 2 and 89.4% in Model 3. A frequency distribution of the predicted cost efficiencies in the decile ranges from 50 to 100 for both models is presented in Figure 2. The figure shows that according to the results of Model 1 and 2 a relatively large number of nursing homes are operating at middle level of cost efficiency, whereas the distribution of cost efficiencies in Model 3 appear less dispersed. This result is not surprising because of the different

approaches used in the analysis.¹⁴ The findings from the deterministic frontier are based on the implicit assumption that all the variation in the error term of the cost function is attributable to inefficiency. This assumption was relaxed using the stochastic frontier models suggested by Aigner et al. (1977) and by Schmidt and Sickles (1984). However, the cost inefficiency results from Model 2 (Schmidt and Sickles (1984) approach) are larger than those calculated from Model 3 (Aigner et al. (1977) approach). This result is not surprising because in Model 2 the difference between the intercepts are interpreted as inefficiencies, and these differences in the intercepts could also be due to time-invariant characteristics of the nursing homes not directly related to inefficiencies such as different logistics. Which of the two stochastic frontier models employed in this paper is to be preferred is not, however, at all clear.

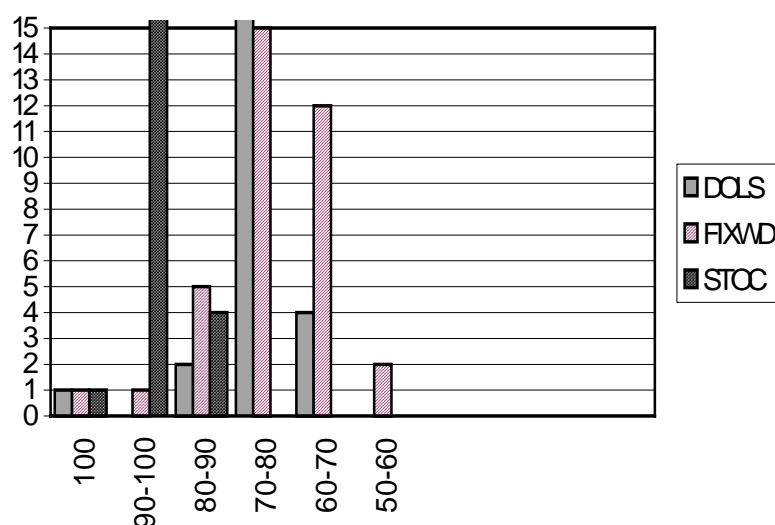


Figure 2 - Distribution of cost efficiency

6. CONCLUSIONS

The purpose of this study was to analyze the cost structure of a sample of Swiss nursing homes in order to assess economies of scale and cost inefficiency. In particular, policy-makers have been interested in cost information to determine the optimal size of a nursing home.

¹⁴ See Cowing et al. (1983) for an interesting discussion on comparison of alternative cost frontier approaches.

Moreover, this paper explores the relationships between cost efficiency and the different forms of institutional organizations (government nursing homes and nonprofit nursing homes).

The paper considers estimation of a deterministic frontier cost model and two versions of a stochastic frontier cost model. A translog cost function was estimated using panel data for a sample of 36 nursing homes over the period 1993-1995. Using a set of dummy variables, quality differences and differences in the forms of institutional organization were considered.

The results of this analysis show that the government nursing homes appear to have higher costs than nonprofit nursing homes, when other factors are taken into consideration. It is unclear what the sources of the cost differences are, but they may reflect the different bureaucratic constraints, which characterize the production process of the public homes. However, it has to be noted that outcomes for residents were not studied, leaving the question of comparative cost-effectiveness unanswered.

The empirical evidence indicates the existence of economies of scale for most output levels. This result suggests that for the building of new nursing homes, the effects of the size on the costs has to be taken into account.

References

- Aigner, D., C. A. K. Lovell and P. Schmidt (1977), 'Formulation and Estimation of Stochastic Frontier Production Function Models', *Journal of Econometrics*, 6, 21-37.
- Baltagi, B.H. and Griffin, J.M. (1984), 'Short and Long-run Effects in Pooled Models', *International Economic Review* 25, 631-645.
- Battese, G. E. (1992), 'Frontier Production Functions and Technical Efficiency: A Survey of Empirical Applications in Agricultural Economics', *Agricultural Economics*, 7, 185-208.
- Battese, G. E., and T. J. Coelli (1988), 'Prediction of Firm-level Technical Efficiencies with a Generalised Frontier Production Function and Panel Data', *Journal of Econometrics*, 33, 387-399.
- Bradford W.D. and Mobley L.R. (1997) 'Behavioural differences among hospitals: it is ownership or location?', *Applied economics*, 29, 1125-1138.
- Caves, W.C., Christensen, L.R. and Tretheway, M.W. (1984), Economies of Density versus Economies of scale: Why trunk and Local Service Airline Costs Differ, *Rand journal of Economics*, 15, 471-489.
- Coelli, T. J. (1996), 'A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation', Mimeo, Department of Econometrics, University of New England, Armidale.
- Cornes, R., (1992), *Duality and Modern Economics*. Cambridge University Press.
- Cowing, T., Reifschneider, D. and Stevenson (1983), R. 'A Comparison of Alternative Frontier Cost Function Specifications'. In Dogramaci, A.: *Developments in Econometric Analyses of Productivity*, Boston.
- Cornwell, C., P. Schmidt and R. C Sickles (1990), "Production Frontier with Cross-sectional and Time-series Variation in Efficiency Levels", *Journal of Econometrics*, 46, 185-200
- Filippini, M. and Maggi, R. (1993), Efficiency and Regulation in the case of the Swiss Private Railways, *Journal of regulatory Economics*, 5, 199-216.

- Friedlaender, A.F. and Wang Chiang, S.J. (1983), 'Productivity Growth in the Regulated Trucking Industry', *Research in Transportation and Economics*, 1, pp. 149-184.
- Frisch, R. *Theory of Production*, Dordrecht, 1965.
- Greene, W.H. (1980), 'Maximum Likelihood Estimation of Econometric Frontier Functions', *Journal of Econometrics*, 13, pp. 27-56.
- Jondrow, J., Lowell, C.A.K., Materov, I.S., and Schmidt, P. (1982), 'On the Estimation of technical Inefficiency in the Stochastic Frontier Production Function Model', *Journal of Econometrics*, 19, pp. 233-238.
- McKay N.L., (1990) 'An Econometric Analysis of Costs and Scale Economies in the Nursing Home Industry', *Journal of Human Resources*, 23, 57-75.
- Niskanen W.A. (1968), 'The Peculiar Economics of Bureaucracy', *American Economic Review*, 42, 239-305.
- Niskanen W.A. (1971), *Bureaucracy and Representative Government*, Chicago, Aldine Atherton.
- Wagstaff, A. (1989) "Estimating Efficiency in the Hospital Sector: a Comparison of three Statistical Cost Frontier Models", *Applied Economics*, 21, pp. 659-672.
- Richmond, J. (1974), 'Estimating the Efficiency of Production', *International Economic Review*, 15, pp. 515-521.
- Schmidt, P. and Lowell, C.A. (1979), 'Estimating Technical and Allocative Inefficiency relative to stochastic production and Cost Frontiers', *Journal of Econometrics*, Vol. 9, pp. 343-366.
- Schmidt, P. and R.E. Sickles, (1984), Production Frontiers and Panel Data, *Journal of Business and Economic Statistics*, 2, 367-374.
- Simar, L., (1992), 'Estimating Efficiencies from Frontier Models with Panel Data: A Comparison of Parametric, Non-parametric and Semi-parametric Methods with Bootstrapping', *The Journal of Productivity Analysis*, 3, 171-203.
- Vitalino D.F., Toren M., (1994). Cost and efficiency in nursing homes: a stochastic frontier approach', *Journal of Health economics*, 13, pp. 281-300.
- Weisbrod B.A., (1997) 'The Future of the Nonprofit Sector: its Entwinning with private Enterprise and Government', *Journal of Policy Analysis and Management*, 16, pp. 541-555.

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